lower BHBA (4.8 vs.8.2, 4.5 vs. 9.6 mg/dl, P < .001) than animals fed L. Liver triglyceride at d +21 was lower for animals fed H compared to animals fed L (11.0 vs. 15.6 ug TG/ug DNA, P < .06). A more favorable metabolic profile occurs when increasing the energy density of the diet prepartum or immediately postpartum compared with delaying the increase until d +20 postpartum.

Key Words: Transition cow, Dietary energy, Blood and liver

1219 Changes in hepatic methylmalonylcoenzyme A mutase (MCM, E.C. 5.4.99.2) activity during the transition period in the dairy cows. B. Graulet*[1], A. Desrochers[2], and C.L. Girard[1], [1]*Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Lennoxville,* [2]*Facult de Mdecine Vtrinaire, St-Hyacinthe, Canada.*

The objective was to look at the activity of the hepatic cobalamin-dependent enzyme MCM in dairy cow during the transition period. This enzyme controls the utilisation of methylmalonyl-CoA for neoglucogenesis and thus might be strongly stimulated in dairy cow by the intake of transition and early lactation diets and the increased needs in glucose for milk production. Liver biopsies were taken up repeatedly from 6 multiparous cows 3 wk before calving (-3 wk) and at 2, 4 and 8 wk of lactation. MCM activity was assayed spectrophotometrically from purified mitochondrial matrix. MCM activity decreased from 14.04 ± 1.29 to 7.58 ± .75 nmol/min/mg of intramitochondrial proteins (P < .037) between -3 wk and 2 wk of lactation then returned (P < .004) and stayed at its initial level at wk 4 and 8. Apparent Km and Vmax values towards methylmalonyl-CoA (mean initial values : 175.2 ± 34.0 μM and 19.96 ± 3.16 nmol/min/mg of protein, respectively) followed the same quadratic pattern (P < .052). The dose-response curves of MCM activity towards its cofactor adenosylcobalamin (AdoCbl) indicated the same variations around calving for the apomutase but not for the holomutase part of the activity which remained stable until wk 2 then increased from 4.95 ± .45 to 8.00 ± .80 nmol/min/mg of protein at wk 8 (P < .023). Holomutase activity represented 41.2, 65.3, 61.5 and 59.6 % of total MCM activity at -3, 2, 4 and 8 wk, respectively. This increase was associated to a reduction in plasma vitamin B12 concentrations (-33 %, P < .003). Apparent Vmax values towards AdoCbl (initial level 8.59 ± .71 nmol/min/mg of protein) varied also quadratically. Apparent Km values towards AdoCbl were constant until wk 2 (.58 ± .20 to .69 ± .14 μM), decreased by 36 % at wk 4 (P < .056) and then returned to the inital values at wk 8 (P < .001). Our results show that MCM activity is decreased during the first weeks of lactation and consequently might reduce neoglucogenesis.

Key Words: MethylmalonylCoA mutase, Cow, Lactation

1220 Effects of a modified stair-step compensatory growth model for gestating beef heifers. A. M. Encinias*, H. B. Encinias, T. D. Klein, G. P. Lardy, M. L . Bauer, and C. S. Park, [1]*North Dakota State University, Fargo, ND USA.*

Thirty-six gestating Angus and Angus-cross heifers were used to evaluate the effects of energy restriction imposed at 90 d of gestation. Heifers were grouped by verified AI date into six pens (6 heifers/pen) and fed a grass hay/corn silage diet for 10 d. At 90 d of gestation, pens of heifers were assigned randomly to one of two dietary energy treatments: control (CON) or stair-step (SS). Control heifers were fed 20.4 Mcal ME/d from d 90 to 210 of gestation and 23.0 Mcal ME/d through d 270, to achieve 0.54 kg ADG (minus fetus). Stair-step heifers were fed 13.3 Mcal ME/d (65% of CON) from d 90 to 210 (restriction) of gestation and 29.9 Mcal ME/d (130% CON) through d 270 (refeeding). During restriction, diet was formulated to elicit no gain (minus fetus) in SS heifers. Three-day consecutive weights were used to measure initial and final period BW. Initial and final body condition was estimated for each period. Initial BW ($P = 0.72$; 463 (CON) vs 474 (SS) ± 21) and BCS ($P = 0.81$; 6.1 vs 6.1 ± 0.1) were not different between treatments. Imposed restriction, did not influence BW ($P = 0.20$; 540 vs 490 ± 26 kg) between CON and SS, respectively. However, by design, CON heifers had a greater BW change ($P = 0.004$; 77 vs 16 ± 8 kg) and ADG ($P = 0.004$; 0.64 vs 0.13 ± 0.06 kg) during the restriction period. As a result SS heifers decreased ($P = 0.001$) in BCS. During refeeding phase, compensatory response (2.77 kg ADG) was observed in SS through d 28. Energetic efficiency (kg ADG:Mcal ME) was also greater for SS during refeeding ($P = 0.002$; 0.054 vs 0.031). In addition, SS heifers achieved a higher ADG ($P = 0.001$; 1.61 vs 0.73 ± 0.05 kg) than CON during refeeding. At the conclusion of feeding phase, heifer BW ($P = 0.95$; 584 vs 587 ± 13 kg) and BCS ($P = 0.70$; 6.2 vs 6.1 ± 0.2) were similar among CON and SS, respectively. Compensatory response elicited by SS during refeeding, allowed heifers to reach a similar final BW and BCS compared to conventionally reared gestating beef heifers.

Key Words: Beef heifer, Stair-step compensatory growth, Gestation

PSA Processing and Products

1221 Influence of CO_2 cryogenic cooling on low populations of *Salmonella* Enteritidis in inoculated table eggs. J.B. Gurtler* and D.E. Conner, *Department of Poultry Science, Poultry Product Safety and Quality Program, Auburn University, AL .*

Because Salmonella Enteritidis (SE) is the primary cause of foodborne illnesses arising from table eggs, there is interest in developing processes to limit SE risk. Cryogenic cooling with CO_2 improves microbial counts of naturally contaminated eggs and can reduce high SE populations in inoculated eggs. Furthermore, elevated CO_2 levels decrease SE growth in yolk-containing media. The present study was undertaken to determine the effects of CO_2 cryogenic cooling on SE propagation in eggs at low inoculum levels. Fresh eggs (with a mean temperature of 27C) were gathered and inoculated, via injection into albumen, to *ca.* 160 cfu/egg with SE. One half of the eggs were cooled at *ca.* -60C for 6 min with CO_2 in a prototype cryogenic cooling unit, producing a post-cooling egg temperature of 12.9C, and then stored at 7C. The remaining eggs were traditionally cooled, requiring 5 days to achieve 7C and held at that temperature thereafter. Egg pH and SE populations were determined every three days up to day 15 and then weekly up to day 49 of storage. Populations of SE remained static over the 49 days following cryogenic cooling, whereas SE populations increased significantly in traditionally cooled eggs. After day 6, cryogenically cooled eggs' SE populations were consistently 2.5-4.5 $\log_{10}$ cfu/ml lower than those traditionally cooled. No marked difference was noticed in pH values. Rapid cooling with CO_2 effectively inhibited SE growth in stored table eggs, and therefore may provide an efficient controlled cooling process for maintaining and increasing safety of table eggs.

Key Words: *Salmonella* Enteritidis, eggs, CO_2

1222 Effect of soybean soapstock on laying hen performance and egg quality parameters. V. Pardio*[1], L. Landin[1], K. Waliszewski[2], M. Avalos[1], A. Flores[1], and L. Guzman[1], [1]*Universidad Veracruzana, Veracruz, Veracruz/Mexico,* [2]*Instituto Tecnolgico de Veracruz, Veracruz, Veracruz/Mexico.*

The aim of the study was to determine the effects of soybean soapstock in laying hen diets on performance and egg quality parameters since variations in feed can adversely affect egg parameters resulting in economic losses to poultry producers. A total of 192 White Leghorn laying hens, 20 wk of age, was housed in two double-deck cage batteries with 4 birds in each cage at 25C. The birds were allotted to six dietary treatments, with each treatment replicated four times randomly among the batteries with 8 birds for replicate. The diets were sorghum-meal ground based with soybean oil at 3.5% and were isocaloric and isonitrogenous. Feed and water were provided for *ad libitum* consumption. Diet T1 had 25%, diet T2 50%, diet T3 75% and diet T4 100% of soybean soapstock, which was added in the amount to reach the requirement of 1.5% linoleic acid and complemented with soybean oil, control diet with pigment (T5) and control diet without pigment (T6) had 100% soybean oil. Four eggs from each replicate were randomly selected daily during eight weeks, kept at 4C and analyzed within two days after collection for determination of egg quality parameters: egg weight, shell thickness, Haugh unit score, albumen and shape index. Production performance -number and weight of eggs produced, feed conversion and percentage of production per treatment were recorded. Data were analyzed by ANOVA (P<0.05) and significant differences among treatment means were analyzed by Tukey and Dunnett tests using Minitab 10.5 statistical program. Results indicated that the egg quality parameters among treatments were not statistically different during the eight weeks. No statistical differences were observed in production performance during the first two

weeks but statistical difference was observed among T1, T2 and T3 diets with T4, T5 and T6 diets from the third to sixth week and no statistical difference was observed among T4, T5 and T6 diets. There were no statistical differences among treatments at the seven and eight weeks of production. Nevertheless, T4 production parameters were numerically higher than other treatments. Soybean soapstock can be recommended as a substitute of vegetable oil since no adverse effects on egg quality and production parameters were detected.

Key Words: Soybean soapstock, egg quality , production performance

1223 Development of generic HACCP model plans for the egg processing industry. Mindy Brashears[1], Shelly McKee-Hensarling[1], Jason Mann*[1], and Dennis Burson[1], [1]*University of Nebraska*.

To assist the egg processing industry with HACCP implementation and to help ensure the consuming public a safe egg product supply, a team of Extension Specialists with expertise in food safety, Hazard Analysis and Critical Control Points (HACCP) systems and egg processing developed 5 generic HACCP plans similar to those available for use at the USDA by meat and poultry processors. After examining various egg processes, 5 process categories were identified based on similarities among the various processes. The categories were as follows; not ready-to-eat shell eggs; spray dried egg products; pasteurized liquid egg products; ready-to-eat, heat treated egg products-boiled; and ready to eat specialty egg products. A flow diagram and product category description was developed for each category and verified by industry experts. The seven principles of HACCP as described by the National Advisory Committee for the Microbiological Criteria for Foods were followed to develop the HACCP plans. The majority of the hazards identified were microbial, primarily Salmonella. Metal could also be a significant hazard in some processes. For pasteurized liquid egg products, Critical Control Points (CCPs) were identified at the pasteurization step and the cooling steps. Pasteurization was also a CCP for the spray dried egg products. Ready to eat specialty egg products and boiled egg products had CCPs identified at the cooking and/or pasteurization steps, depending on the process. For the shell eggs, there were no kill steps in the process so storage temperatures and the anti-microbial wash steps were identified as being critical to ensure safety of the product. The generic plans also contain a list of references to support decisions made in the hazard analysis section of the plans. An overview of HACCP and how to use the generic plans are also included. The generic plans will be available to processors in hard copy format, electronic/CD ROM format and on-line for use by egg processors.

Key Words: egg processing, HACCP, Food Safety

1224 Tuna Oil as n-3 Fatty Acids Source to Egg Yolk. C. Castillo Badillo[1], M. Gonzlez Alcorta[1], E. Morales Barrera[2], S. Carrillo Domnguez*[3], and R.M. Castillo Domnguez[3], [1]*Universidad Autonoma de Chapingo. Chapingo,Texcoco. Mexico,* [2]*Instituto Nacional de Investigaciones Forestales, Agrcolas y Forestales. Chapingo, Texcoco. Mexico,* [3]*Instituto Nacional de Ciencias Mdicas y Nutricion Salvador Zubirn, Mexico D.F., Mexico*.

The inclusion of tuna oil in the laying hens diet can redound in benefits for the human health because it enrich the egg with fatty acids omega 3, which diminishes the cardiovascular human disease incidence. The aim of this study was to evaluate the effect of substitution safflower oil by tuna oil in the laying hens ration, on egg lipids and fatty acids omega-6 and omega-3 content. The study was carried out with 160 Leghorn laying hens, 90 weeks old, allocated in four treatments (3:0, 2:1, 1:2, 0:3) with four replicates each one. The experimental data were collected during 56 days. It was carried out two egg sampling, at the 28 and at the 56 experimental days. It were randomly taken four eggs of each replicate. The eggs were freezing. AGn-6 and AGn-3 were analyzed by gas chromatography. It was not detected any significant difference ($P>0.05$) on the egg total lipids (TL) content at the first 28 experimental days. However, the AGn-3 egg content (mainly EPA and DHA) increased to 30 mg/g lipid in the treatment 2:1. To 56 days the TL content was reduced 7% in the same group and the egg fatty acids content was higher significantly ($P<0.05$), obtained until 32mg/g lipid AGn-3, mainly EPA and DHA. Those observations suggest that tuna oil dietary inclusion has a positive relationship with the fatty acids omega-3 egg enrichment.

Key Words: Tuna oil, n-3 Fatty acids, egg yolk

1225 Effect of cooking methods and packaging conditions on the TBARS and COPs of turkey thigh meat patties during storage. S. J. Hur*, M. Du, K. C. Nam, Y. H. Kim, and D. U. Ahn, *Iowa state university*.

Turkey thigh meats with skin were ground twice through a 3-mm plate and patties were prepared. Patties were cooked using 5 different methods (pan frying, oil deep frying, boiling, oven cooking, and microwaving) to an internal temperature of 85-90°C and packaged in either oxygen permeable PVC zipperbags or oxygen impermeable PVDC bags. The samples were analysed for TBARS and cholesterol oxidation products (COPs) after 0, 3, and 7 days of storage at 4°C. The TBARS of cooked meat increased during the storage regardless of cooking methods, but vacuum packaged thigh meat produced less TBARS and COPs than the aerobically packaged samples. At the beging of storage, aerobically packaged meat cooked by boiling method produced higher TBARS than that of others. However, the TBARS of microwavied meat with vacuum packaging increased rapidly after 3 days of storage at 4°C. The amount of total COPs in cooked thigh meat increased with storage and the increase was linear with storage time. The level of total COPs in aerobically packaged cooked meat was higher than the vacuum-packaged meat. Microwaving produced higher level of total COPs in meat than other cooking methods during storage. The results indicated that the progress of cholesterol oxidation in cooked meat was similar to that of lipid oxidation, and the formation of lipid and cholesterol oxidation products in cooked meat was closely related to cooking temperature, cooking time, storage time, and packaging conditions.

Key Words: cooking methods, cholesterol oxidation products , TBARS

1226 Identification of Bacteria Found in Broiler Deboning Operations. Tam Mai* and Donald Conner, *Auburn University*.

Research was conducted to identify bacterial community members found in broiler deboning operations. The objectives of this study were to gain a general idea of identity of bacteria in chicken products and the processing environment, and to determine effects of processing on bacterial types. Samples were collected at random at the postchill-debone lines of the same commercial processing facility over three visits. Collection at each sampling time consisted of 20 whole carcass (C), 20 breast meat (B), 20 skin (S), and 20 equipment (E) samples. Each sample was cultured on tryptic soy agar, incubated at 37^0C for 24 hours. Colonies with different morphology were picked and streaked for isolation. Using this procedure, a total of 600 bacterial isolates were obtained (201 C, 222 B, 80 S, 97 E). Each isolate was identified based on whole cell lipid composition. Among the 600 isolates, there were 35 different genera, representing 100 different species. *Staphylococcus* (21%), *Pseudomonas* (17%), *Flavobacterium* (16%), and *Acinetobacter* (13%) were the predominant genera. Bacterial community composition varied at the different sampling times; however, similar genera of bacteria were found consistently in breast meat and on processing equipment. Data indicate that predominant bacterial types in broiler meat change as products are processed.

Key Words: Bacteria, Identification, Processing

1227 Broiler skin and meat color changes during storage. M. Petracci*[2] and D. L. Fletcher[1], [1]*University of Georgia, Athens, USA,* [2]*University of Bologna, Bologna, ITALY*.

It has been reported that both broiler skin color and meat color change during slaughter, processing, and storage. In recent years, systems have been developed for the express purpose of using computer based machine vision for evaluating carcass and meat quality. Many of these systems use color discrimination as a criteria. Therefore, a better understanding of the time scale and degree of color change is necessary to calibrate such systems and to predict ultimate product color. Four experiments were conducted to study the color changes during processing and storage of broiler carcass skin, and breast and leg meat. For skin color, broilers were subjected to either a semi-scald (50 C for 120 sec) or a sub-scald (57 C for 90 sec). Color was measured both on and off the pectoral feather tract. For breast and leg meat color, color was measured directly on the meat surface (without packaging) or on the packaged meat surface. CIELAB color values of lightness (L*), redness (a*), and yellowness (b*)

were measured every 20 min for the first 3 hours, every 30 minutes between 3 and 8 hours, hourly between 8 and 12 hours, and daily for 8 days. Results clearly show that both skin and meat color change dramatically during the first 6 hours postmortem, after which the change is less dramatic over the 8 days of storage. Semi-scalded birds changed more than sub-scalded birds, presumably due to the more stable color of the xanthophylls in the epidermis and less influence of changes in the underlying muscle tissue. These results show that computer assisted vision or color systems must account for these changes and should be factored into system calibration. Also, early color analyses for market products, although highly correlated with later product color, may not reflect final product color specifications.

Key Words: Broiler skin color, Broiler meat color, Color change during storage

1228 Use of marine algae to enrich DHA content of heavy broiler breast and thigh muscle. J.E. Garrett*[1], J.R. Abril[1], and M.D. Sims[2], [1]*Omega Tech, Inc., Boulder, CO,* [2]*Virginia Scientific Research, Harrisonburg, VA.*

The production of meat enriched with omega-3 fatty acids has the potential to provide an alternative source to fatty fish for of these nutrients. Four hundred 44-day old broilers (200 male and 200 female) were sorted by sex randomly allotted to one of four treatments: Control (C); 17 g algae/bird/wk for 7 days followed by 3 g algae/bird/wk for 7 days (N); 10 g algae/bird/wk for 2 wks (E); and 34 g algae/bird/wk for 7 days followed by 6 g algae/bird/wk for 7 days (D). Marine algae used study was DHA Gold®, Omega Tech, Inc., a rich source of decosahexaenoic acid (DHA). Diets were formulated to meet NRC requirements. Bird performance was not significantly (P>.05) affected by any treatment. At the end of the two-week feeding period, 30 males and 30 females were collected from each treatment and processed for carcass data. Twenty carcasses (10 male and 10 female)/trt were processed ready to cook and then ground for analysis, 20 carcasses (10 male and 10 female)/trt had breasts and thighs removed for analysis and 20 carcasses (10 male and 10 female)/trt were retained for sensory panel evaluation. Breast muscle had the following DHA concentration (mg/ 100 g of tissue) 9.6, 35.8, 50.7 and 69.7 for C, N, E and D, respectively. Thigh muscle had the following DHA concentration (mg/100 g of tissue) 12.2, 54.3, 76.4 and 109.2 for C, N, E and D. Each treatment resulted in a significant in enrichment from other treatments. Sensory panel evaluation showed no difference in breast quality for 3 or 10 day cold storage, with the exception that breasts from D were identifiable but not objectionable. Thigh quality showed similar results with no difference in quality though D thighs were identifiable at 3 and 10 days of cold storage. Efficiency of enrichment of DHA averaged 20.6, 25.7 and 21.4% for N, E and D, respectively. Conclusions from this study indicate that feeding of marine algae is a viable method to provide an alternative source of DHA compared to traditional fish sources.

Key Words: Omega-3 fatty acids, Broiler, DHA, Breast muscle, Thigh muscle

1229 Growth of *Campylobacter jejuni* under Acidic Conditions. Lei Zhang* and Donald Conner, *Auburn University.*

Campylobacter jejuni is a prominent cause of human bacterial gastroenteritis, and there is a high prevalence of the organisms in raw poultry products. Acid resistance is an important factor affecting ability of enteric bacteria to colonize the GI tract, therefore, acid tolerance can affect efficiency of subsequent acidic treatments in eliminating enteric pathogens from processed carcasses. To test the effect of pH reduction on growth of *C. jejuni*, Brucella broth was acidified with citric, hydrochloric, or tartaric acid to pH 4.5-6.5 in 0.5 unit increments. Triplicate tubes with 10 ml acidified Brucella broth were inoculated with *C. jejuni* (10^4 CFU/ml) and incubated in an atmosphere of 10% CO_2, 5% O_2 and 85% N_2 at 42 °C. CCDA and Campy-Cefex plating media were used to enumerate *C. jejuni* at 0, 48, and 96 hours. The minimum test pH at which *C. jejuni* did not grow (inhibitory pH) was determined for each acid. In the pH range tested, the inhibitory pH was 4.5 for citric and hydrochloric acids, and pH 5.0 for tartaric acid. In the non-inhibitory pH range (pH 5.0-6.5 for citric and hydrochloric acids, pH 5.5-6.5 for tartaric acid), initial populations of viable cells increased to their highest numbers at 48 hours. Populations of viable cells were 2-3 LOG_{10} CFU/ml higher at pH 6.5 than at the lowest pH value at which growth occurred (pH 5.0 for citric and hydrochloric acid, 5.5 for tartaric acids). Results showed that *C. jejuni* has the ability to grow at moderately acidic environments; however, type of acidulant affects survival.

Key Words: *Campylobacter jejuni*, acidic conditions, growth

1230 Comparison of carcass damage in turkeys stunned on constant voltage and constant amperage electrical pre-slaughter stunning systems. J.D. Reiman* and J.A. Marcy, *University of Arkansas.*

Unacceptable carcass damage, primarily hemorrhage in the breast muscles, has been associated with electrical stunning systems. One factor that may induce hemorrhage is the fluctuation of current (amperage) applied to a single bird. This fluctuation is a function of the variation in resistance between birds and with the number of birds in the system in a constant voltage stunner. In four experiments, turkeys were stunned with either a constant voltage (DC, 480 Hz) or constant amperage (square wave AC, 480 Hz) electrical pre-slaughter stunning system, processed and evaluated for carcass damage. For each experiment, 60 commercially grown 4.5-6.5 kg female turkeys where randomly and individually subjected to one of four stun treatments (low constant voltage 13 V; high constant voltage 32 V; low constant amperage 10 mA; high constant amperage 25 mA). The physical reaction at the time of stun and during exsanguination was observed as the turkeys were processed though an automated slaughter system. The carcasses were chilled and held for 24 hours before cut-up and visual inspection. At 24 hours, each carcass was fabricated, the parts subjectively scored to describe the presence and severity of hemorrhagic damage, the pH of the breast muscle recorded (0.25, 1, 2, 24 h) and CIE L*a*b* values (24 h) measured. No difference (P<0.05) in carcass damage was observed between any of the electrical stunning treatments. A lower pH (P<0.001) occurred at 1 and 2 hours for both the low voltage and low amperage treatments. This may have resulted from a more rapid state of rigor development caused by greater physical activity at the time of stun, venisection and exsanguination as supported by higher stun reaction scores and observations. These results suggest little difference between constant voltage and constant current systems for preventing hemorrhaging in turkey carcasses along the parameters used in this study.

Key Words: Stunning, Turkey, Carcass damage

1231 Survival of Campylobacter jejuni on Poultry Skin and Meat at Varying Temperatures. M. A. Davis* and D. E. Conner, *Auburn University, AL, USA.*

Recent research showing a much higher prevalence of Campylobacter on skin-on poultry products vs skinless products suggests that contamination is associated primarily with poultry skin and that Campylobacter may not survive well on poultry meat. Therefore, survival of Campylobacter on poultry skin vs. meat was quantified. Pieces of skin and meat were irradiated to eliminate native microflora, and inoculated with Campylobacter jejuni (>5.0 x 10^5 cfu/ml). Meat and skin samples were packaged in polystyrene trays, covered with Cryovac® film, then subjected to one of the following storage conditions: 1) 4C for 11 days, 2) 4C for one day, then -3C for 10 days, 3) 4C for one day, -3C for one day, then 4C for 9 days, or 4) 4C for one day, -3C for one day, 20C for one hour on day 2, then 4C for 9 days. On days 0, 2, 3, 5, 7, 9 and 11, populations of Campylobacter were determined. The experiment was replicated three times. In each experiment, populations of surviving Campylobacter were not affected by storage conditions ($p \geq 0.05$), and there was no interaction between temperature treatments and sample type. Surviving Campylobacter populations were affected ($p < 0.05$) by sample type (skin vs meat). Campylobacter, in the absence of competing microflora, survived well on both poultry skin and meat at the varying temperatures tested. In all experiments, higher populations were established on the inoculated skin vs inoculated meat. These populations remained consistently 0.4-0.9 $\log_{10}$ cfu/g higher on skin vs meat. Poultry skin topography, which provides for rapid attachment and entrapment of Campylobacter, may account, in part, for these higher populations on skin.

Key Words: Campylobacter, Poultry, Skin

1232 Comparison of electrolyzed oxidizing water with various antimicrobial interventions to reduce Salmonella spp. on poultry. K. A. Barstad*, R. R. Sharma, A. Demirci, and C. N. Cutter, *Penn State University*.

Recently, electrolyzed oxidizing (EO) water has been demonstrated to significantly reduce foodborne pathogens associated with cutting boards, vegetables, and cell suspensions. EO water is generated by passing a dilute salt solution through an electrical field, resulting in a solution with a pH of approximately 2.6, a residual chlorine level of 10-60 mg/liter, and oxidation-reduction potential of about 1,150 mV. In this study, EO water, chlorine (CL), ozonated water (OZ), acetic acid (AA), and trisodium phosphate (TSP) were used to treat freshly slaughtered chicken carcasses experimentally inoculated with Salmonella Typhimurium ATCC 13311. Antimicrobials were applied to inoculated carcasses either by submersion (4C, 45 min) or spray washing (85 psi, 25C, 15 sec). Following treatments, remaining bacterial populations were determined and compared at day 0 and after 7 days of refrigerated storage. Immediately following submersion experiments, treatments with TSP and AA demonstrated a 1.41 log10 reduction of S. Typhimurium, while EO water reduced the pathogen approximately 0.86 log10. After 7 days of aerobic storage at 4C, EO water, OZ, TSP, and AA significantly reduced the pathogen, with detection of the pathogen only after selective enrichment. Remaining bacterial populations immediately following spray washing experiments were not statistically significant between treatments at day 0; TSP and EO water exhibited a 0.9 and 0.59 log10 reduction of S. Typhimurium, respectively. After seven days of refrigerated storage, TSP, AA, and EO water affected a 2.17, 2.31, and 1.06 log10 reduction, respectively. While TSP and AA are effective in reducing S. Typhimurium in these experiments, these compounds may be expensive for processors to use and can adversely affect the environment following disposal. The data from this study suggest that EO water, delivered to contaminated surfaces by submersion or spray washing, can effectively control pathogens on poultry surfaces, especially following extended refrigerated storage. In order to improve the immediate and long-term effect of EO water spray washing treatments against S. Typhimurium associated with poultry surfaces, further optimization studies are warranted.

Key Words: Electrolyzed oxidizing water, Salmonella spp., processing

1233 Application of Sodium Citrate or Sodium Lactate in Breast Meat Chicken Roll Processing. A. Supatanont[1] and T. C. Chen*[1], [1]*Mississippi State University*.

Studies were conducted to investigate and compare the effects of sodium citrate and sodium lactate on yields and quality characteristics of restructured breast meat chicken roll. Chicken breast meats were hand debonded from broiler carcasses, skinned, excess fat removed, and cut into approximately 2.5 cm cubes. The meat cubes were mixed with other ingredients and stuffed into casings to form 6 cm diameter chubs, which were cooked at 82.2C until the internal temperature reached 71.1C. After cooling, processing yields and quality characteristics of the chicken rolls were measured. Processing yield of chicken rolls were increased ($P<0.05$) by the addition of either sodium citrate or sodium lactate. No differences ($P>0.05$) in yield were observed among the 0.25%, 0.50%, and 0.75% of either of the additives. When compared to those of the non-treated controls, the Hunter color readings, WB shear values, and Hedonic sensory scores of chicken rolls were not affected ($P>0.05$) by the addition of either sodium citrate or sodium lactate. The refrigerated shelf life of chicken rolls were effectively extended by the presence of sodium citrate or sodium lactate. The presence of 0.50% sodium citrate also retarded ($P<0.05$) the rancidity development of chicken rolls, while little or no effects were observed for the sodium lactate. Data suggested that sodium citrate can serve as an alternate for the preservation of processed muscle foods.

Key Words: chicken roll, sodium citrate, sodium lactate

1234 Influence of measurement position on the color values of turkey breast meat. T. J. Buttles[1], J. Kalbfleisch[1], S. L. Noll[1], and B. S. Walters*[2], [1]*University of Minnesota, St. Paul, MN,* [2]*University of Wisconsin - River Falls, River Falls, WI*.

Color has been identified as a quick, non-destructive method to screen poultry meat for abnormal muscle characteristics including pale, soft, and exudative (PSE). A uniform protocol for taking color measurements has not been developed. One of the factors in developing a standard protocol is determining where to take the measurement. The objective of this study was to determine if different positions on the muscle give different color readings. CIE color readings for lightness (L*)were taken on breast meat from 104, 20-wk-old turkey toms. The breast meat was deboned 24h postmortem and the color readings taken immediately after deboning. Ten different locations on the internal surface, 5 on each half of the breast, were analyzed. The mean L* value was 49.75. Linear correlations between the 10 locations were determined by Pearson's correlation coefficients. The L* values at the different positions were positively correlated, with values ranging from 0.12 to 0.71 with a mean value of 0.34. While many of these correlations were statistically significant, they did not show strong correlations. These results indicate that the position of the measurement may impact how the meat is categorized as normal versus light or dark. Further research is needed to confirm these results and to determine the best position for taking color measurements.

Key Words: Turkey, Meat color, Poultry

1235 Pinking in further-processed turkey due to residual nitrate reduction by *Pseudomonas fluorescens*. Chad Clem* and John Marcy, *University of Arkansas, Fayetteville, AR*.

Cooked poultry products occasionally develop a "pink" tint that is unappealing to consumers. A possible reason for this color development is the microbial reduction of residual nitrate in the processing water. This study investigated the role of *Pseudomonas fluorescens* in the nitrate reduction of processed turkey and the resulting pink discoloration found in the meat. Shaved turkey product, divided into 12 groups, was inoculated with 0, 50, or 200 ppm sodium nitrate ($NaNO_3$). Half of the treatments also received inoculums of *P. fluorescens*. After stuffing into impermeable casings and storing for either 12 or 60 h, the meat was cooked to 82 C and then evaluated for nitrite ($NaNO_2$) and color differences by colorimeter and sensory panel. The mean colorimeter value for redness from the samples treated with 200 ppm $NaNO_3$ and bacteria and stored for 60 h was 4.07, whereas that of the samples that were not treated with any $NaNO_3$ or bacteria and were held for only 12 h was 2.65. Sensory panels also rated samples treated with 200 ppm $NaNO_3$ significantly pinker than samples containing no added $NaNO_3$. Storage time had a significant effect on the color of the turkey with 60 h treatments receiving significantly higher redness values than 12 h treatments. The samples with the highest $NaNO_3$ treatments that also received *P. fluorescens* inoculums produced the greatest $NaNO_2$ levels after cooking. These results indicate residual $NaNO_3$, *P. fluorescens*, and extended storage time may all contribute to the unwanted pink color development that is sometimes seen in further-processed turkey meat.

Key Words: Pinking, Bacterial Nitrate Reduction, Processed Turkey Meat

1236 Effect of rosemary oleoresin on quality of ground thigh chicken meat packed in high oxygen modified atmosphere environment. T. Keokamnerd*, I. Y. Han, and P.L. Dawson, *Clemson University, Clemson, SC*.

This research was conduct to compare an antioxidant effect of four different rosemary oleoresin extracts and a control sample (no antioxidant added) on quality of ground chicken thigh packed in a high oxygen modified atmosphere (80% O_2 : 20% CO_2). All samples were stored in the "dark" at $0\pm3^{\circ}$C from day 0 to day 3, after that the meat samples were transferred to a "lighted" refrigerator at $3\ \pm1^{\circ}$C with a light intensity of approximately 850 lux. Color, total aerobic plate count, and TBARS of ground chicken meat were measured at days 0, 3, 6, 9 and 12. The sensory impact of rosemary oleoresin on odor and flavor of the samples was evaluated by a panel on day 1. Meat with added antioxidant had a slower rate of increase in TBARS compared to meat without added antioxidant. No difference in color change was observed due to the addition of antioxidant. Antioxidants used in this experiment did not show anti-microbial effect, however, rosemary oleoresin seemed to improve meat odor and flavor.

Key Words: Modified atmosphere, Ground chicken meat, Rosemary oleoresin

1237 Imaging system for fecal and ingesta detection on poultry carcasses. K. C. Lawrence, B. Park, W. R. Windham, and D. P. Smith*, *USDA, ARS*.

A hyperspectral imaging system was developed to detect surface contaminants on poultry carcasses. The system consists of a transportable stand, two quartz halogen line lights, a prism-grating-prism imaging spectrograph connected to a 1280x1024 pixel silicon CCD camera, and a computer with a frame-grabber card. The imaging system is capable of collecting spectral reflectance information from 430 to 900 nm with 1-nm resolution for every pixel of a carcass image. The resulting three-dimensional image cube is typically reduced to 320x340 pixels of spatial information with 512 pixels of spectral information for each spatial pixel. This paper reports the results of this system for the detection of ingesta from the crop or gizzard and feces from the duodenum, ceca, and colon on the surface of a poultry carcass. Sixteen six-week old male birds on a corn/soybean diet were meal-fed, subjected to an 8-hour feed withdrawal, cooped, slaughtered, hard scalded (57.5 C for 2 min.), picked, eviscerated, and feces and ingesta was collected. Uncontaminated carcasses were then immediately imaged. Next, feces and ingesta were applied to varying locations on the breast, wings, and legs of the carcass, typically three spots per contaminant, 12 spots per bird, for a total of 190 contaminant spots, and second images were taken. Results are presented for several data analysis techniques including principal component analysis, which includes all measured wavelengths, and the wavelength ratio of the 565-nm image divided by the 517-nm image. The wavelength-ratio images were further processed with background masking, thresholding, and histogram stretching. The threshold and histogram stretching values were fixed for all birds. Linear and square root histogram stretches were performed. Results indicated that 97.3 and 100 percent of the contaminates were detected with the linear and square-root histogram stretches, respectively. The research shows the feasibility of a real-time system for fecal and ingesta detection from two wavelength images at typical poultry processing line speeds.

Key Words: Feces, Imaging, Food safety

1238 Effects of post-mortem deboning time and L-value classification of raw fillets on color and texture characteristics of cooked broiler breast meat. B. G. Lyon*[1], E. T. Moran[2], C. E. Lyon[1], and E. M. Savage[1], [1]*USDA, ARS, Russell Research Center, Athens, GA*, [2]*Auburn University, Auburn, AL*.

Color of raw broiler meat has consumer implications and may also be indicative of functional properties of the meat. In this study, broiler breast samples from two deboning times were sorted by instrumental color (Minolta); then evaluated for cooked color, aroma and texture. Samples were from 8 wk old male broilers (Ross X Hubbard HiY) subjected to common live production and normal pre-slaughter handling. After processing, *pectoralis majors* were removed from chilled carcasses either at 4-6 h (early, ED) or 24-30 h (late, LD) post-mortem. Fresh fillet light reflectance was measured 48 h after slaughter. Each fillet was IQF, held at 0C, and sorted by L-value (lightness) into two groups, low (<46, LL) or high (>52, HL) from the total having a grand mean of 49. Thawed samples were cooked individually in heat-and-seal bags immersed in 85C water to internal temperature of 78C, and evaluated for aroma, shear force, and light reflectance measurements of outside surface, inside cut surfaces and decanted cook fluid. Thawed raw weight and cooked yield were not significantly different. Cooked L-values for outside and inside cut surface of EDHL were significantly higher than the other three groups. Significant differences in cooked liquid color measurements were found (EDLL < EDHL). Shear force values were significantly higher for EDHL breast meat. Aroma of EDLL was the least brothy, most chickeny and most bloody/serumy; EDHL samples were most metallic. These results agree with other reports that cooking reduces color variation. However, early deboning may present more color differences than late deboning. Further work is needed to elucidate factors that can allow prediction and control of breast meat color and quality.

Key Words: Broiler breast meat color, Instrumental L-values, Deboning time

1239 Lipid and Fatty Acid Composition of Some Specialty Eggs. Gita Cherian*, Troy B. Holsonbake, and Mary P. Goeger, *Oregon State University, Corvallis, Oregon, USA*.

Many specially fed and raised chicken eggs are available in the United States with labels such as 'vegetarian', 'cage-free', 'organic', 'non-medicated', 'naturally-nested' or 'free-range'. The objective of the present study was to compare the egg components, total fat and nutritionally important fatty acids in eggs with special labels or claims. A total of six different brands of eggs with labels such as 'vegetarian high n-3', 'free-range', 'organic', 'uncaged-non-medicated', 'vegetarian-cage-free' or 'cage-free-naturally-nested' were collected and analyzed. A significant (P <.05) difference was observed in the egg components and fatty acid content in different brands. The percent yolk was lower (P <.05) in 'organic' and 'cage-free-vegetarian eggs' with a concomitant increase (P <.05) in the percent white. The percent shell was lower (P <.05) in 'cage-free-vegetarian' and 'naturally-nested cage-free' eggs. No difference (P >.05) was observed in the total edible portion. The total lipids were lower (P <.05) in 'cage-free-vegetarian' eggs. However, this was not noticed in 'free-range', 'vegetarian' or 'naturally-nested-cage-free' eggs. The content of C16:0, C18:0 and total saturated fatty acids were lower (P <.05) in 'vegetarian high n-3' eggs. No difference was observed in the content of C16:1, C18:1 or total monounsaturated fatty acids. The content of n-3 fatty acids were lower (P <.05) in 'organic', 'vegetarian free-range' and 'cage-free' eggs. The ratio of total n-6:n-3 polyunsaturated fatty acids ranged from 39.2 for 'cage-free' to 11.5 for 'vegetarian high n-3' eggs (P <.05). No difference was observed in the total polyunsaturated fatty acid content of eggs (P >.05).

Key Words: Specialty Eggs, Lipids, Fatty Acids

PSA Immunology

1240 Enhanced macrophage function in broilers fed diets supplemented with *E. coli* bacterial cell powder. G. F. Erf*[1], T. K. Bersi[1], and Y. Toride[2], [1]*University of Arkansas, Fayetteville, AR, USA*, [2]*Ajinomoto Co., Inc., Tokyo, Japan*.

Bacteria are important members of the gut flora and are known to play a role in innate immunity. Additionally, bacterial cell wall products such as lipopolysaccharide (LPS) and peptidogylcan are known to have immunopotentiating effects. In chickens, little information is available on immunopotentiating effects of orally administered bacterial cell wall products. This study was designed to examine and compare the effects of dietary administration of purified *E. coli* LPS and of *E. coli* bacterial cell powder (BCP) on macrophage function in broilers. Newly-hatched male broiler chicks were assigned to 8 treatment groups consisting of standard diet (control), standard diet supplemented with 1, 10, 100, or 1000 ppm *E. coli* BCP, or standard diet supplemented with 0.034, 0.34, or 3.4 ppm *E. coli* LPS. When the broilers were 3 to 4 weeks of age, Sephadex-elicited abdominal exudate cells (macrophages) were collected. Macrophages from at least 10 birds per diet were then cultured with or without *in vitro* LPS stimulation to assess oxidative radical production (oxidation of 2',7'-dichlorofluorescein diacetate), nitric oxide production (nitrite assay), and tumoricidal activity (% killing of RP9 tumor cells). Dietary *E. coli* BCP administration did not affect oxidative radical production by macrophages, but did increased macrophage nitric oxide production and tumoricidal activity compared to controls. Similarly, addition of purified *E. coli* LPS to the diet had no effect on oxidative radical production. Macrophages from broilers fed 0.034 ppm *E. coli* LPS exhibited enhanced nitric oxide production and tumoricidal activity, however, these enhancing effects of dietary *E. coli* LPS were masked when macrophages were further stimulated with LPS in culture. Although both *E. coli* products enhanced macrophage function in young broilers, the immunopotentiating effects of *E. coli* BCP were more consistent than those of pure *E. coli* LPS.

Key Words: Broiler macrophage, Lipopolysaccharide , *E. coli* bacterial cell powder